# THE ZOO GOER

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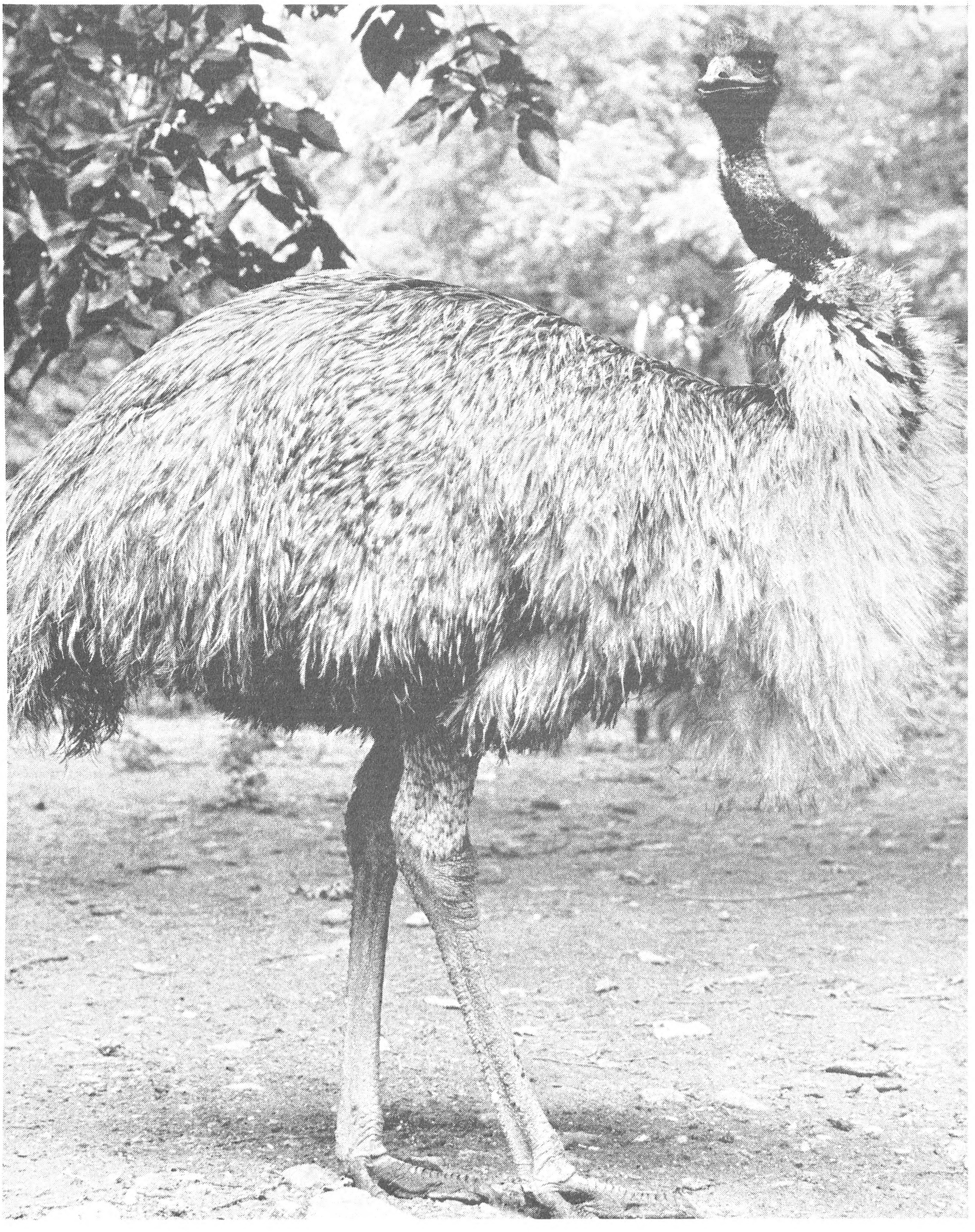

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Photograph on p. 7 left by Pat Vosburgh, all other photographs by Ray Faass.

**Cover: The Zoo's adult female emu (*number 6f on map*); the emu is the second largest living bird.**

Production by Monica Johansen.

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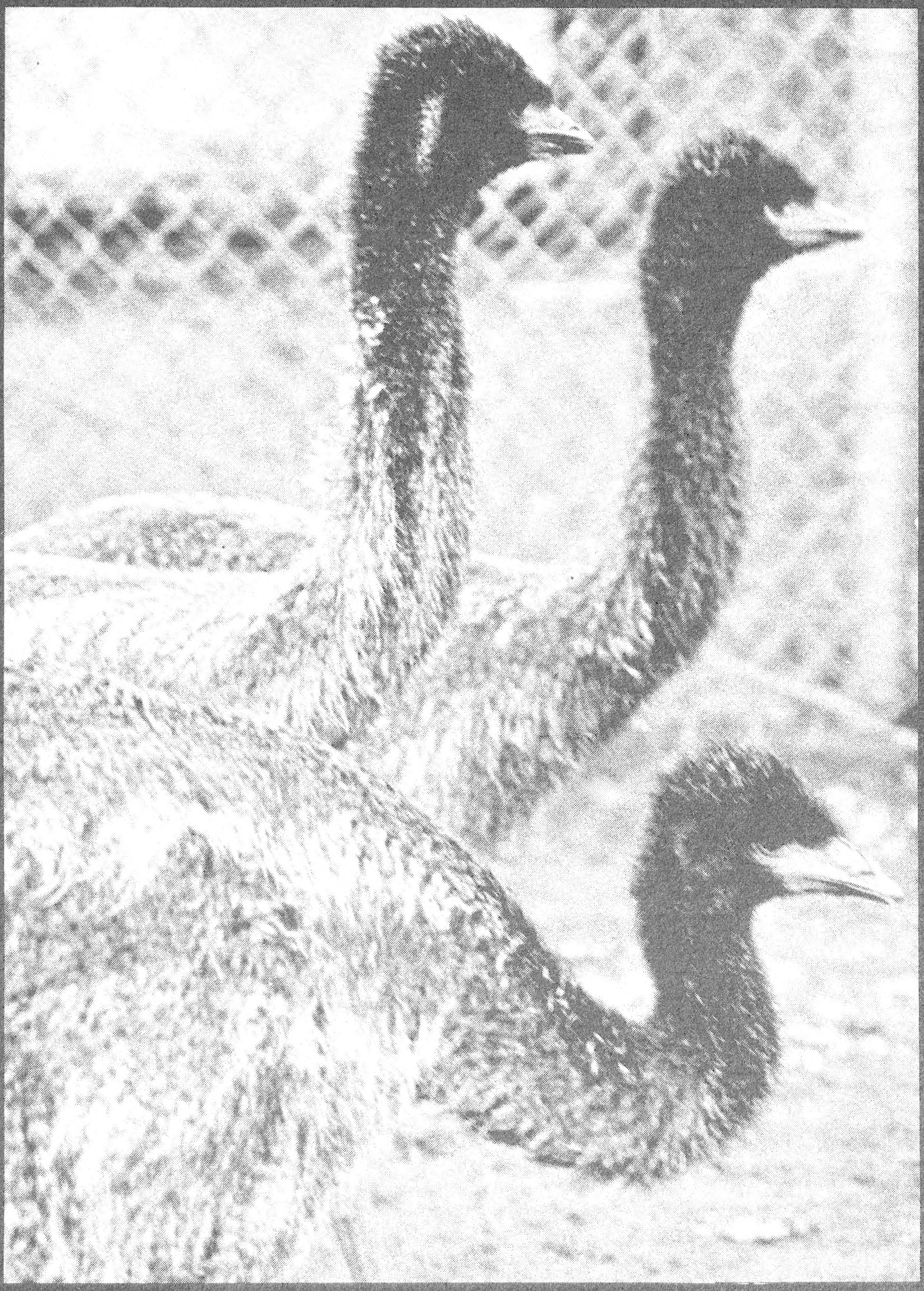
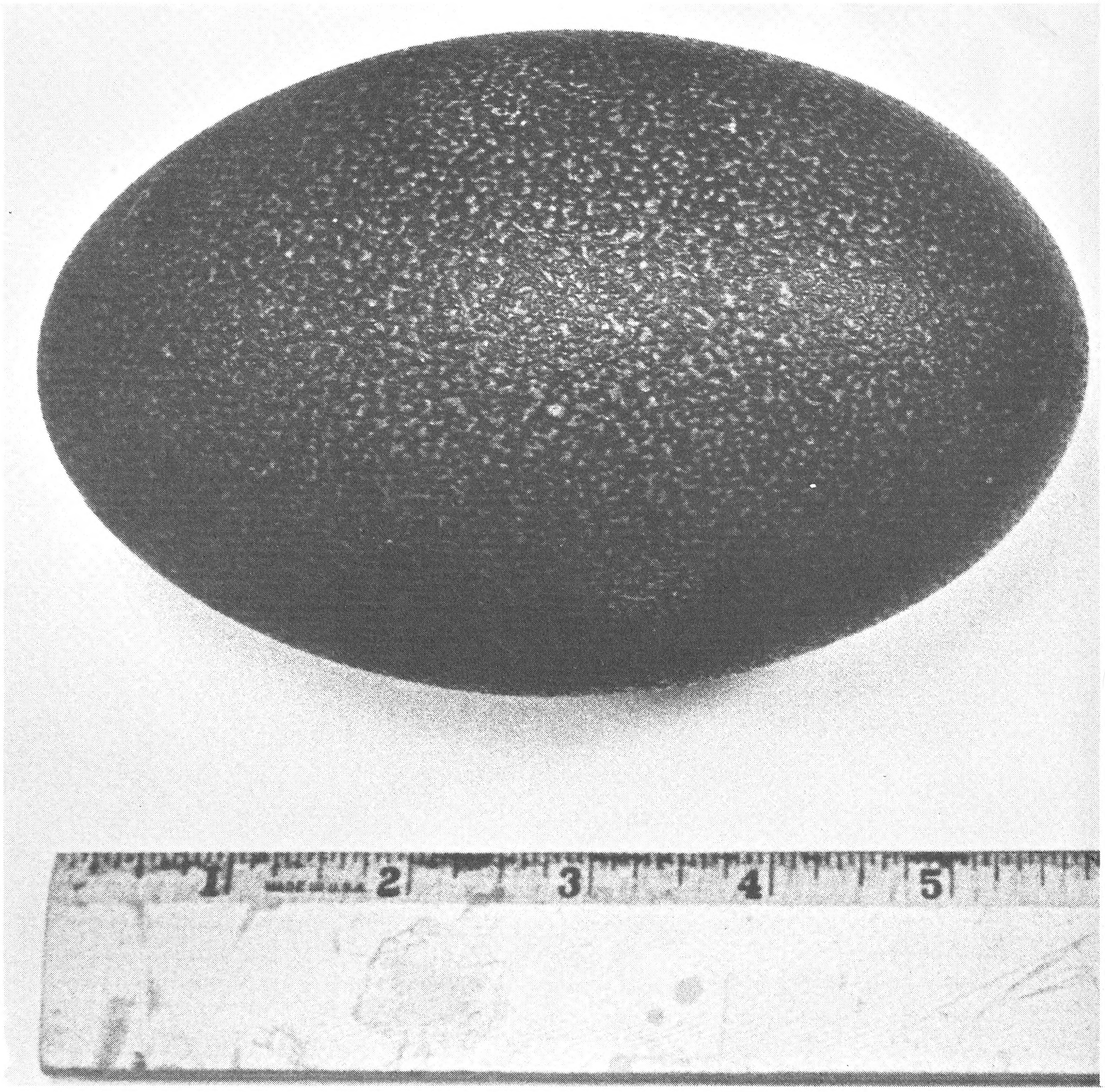


# Emu chicks



An emu egg, which weighs a pound and a half; the shell is dark green in color and quite rough-textured.

The giant flightless emu of Australia is rarely reared successfully in captivity. Though a number of zoos and private breeders have obtained fertile eggs and have succeeded in hatching them, the survival rate of the young has generally been low. It is thus with particular pride that the National Zoo is able to announce that four young emus hatched here in early April are doing well. All are now about two-and-a-half feet tall; and at the age of about two months the four weighed between 14.5 and 16 pounds each.

The emu (*Dromaius novaehollandiae*) is the second-largest living bird; its height of five to six feet is exceeded only by the seven-to-eight foot stature of the ostrich. Like the ostrich it has abandoned flight in favor of a terrestrial life in open country; its tiny vestigial wings ordinarily lie concealed beneath its long, fluffy body feathers. Able to run 30 miles an hour, the emu has come to rely on its speed, size, and keen eyesight to escape predation.

The emus are grouped with the cassowaries—also large, flightless birds—in the order Cassuariformes. The Cassuariformes and three other orders of flightless birds—the ostriches (Struthioniformes), the rheas of South America (Rheiformes), and the kiwis (Apterygiformes)—are known collectively as ratites. Flying birds have a bone attached to

the breast bone that is known, because of its shape, as the "keel"; this bone supports the greatly enlarged breast muscles necessary for flight. The ratites lack this bone; and their name, derived from the Latin word for "raft," refers to this "keel-less" condition. Whether the four ratite orders are closely related to one another or whether they evolved flightlessness separately is not yet known, but ornithologists are agreed that all of them are descended from flying ancestors.

Whether closely related or not, the ratites have in common certain other peculiarities besides flightlessness. In all species, the male alone incubates the eggs; and, either by himself or with the help of females, he cares for the young. In most birds the parents share these duties, or they fall mainly to the female. In addition, in all ratites but the kiwis each male usually mates with more than one female, and all of the females with which he mates lay their eggs in his nest. A male emu—which is smaller than the female—may mate with four or five females, and the total number of eggs laid in his nest may be as high as 25. After laying, each female emu is without further involvement in the reproductive process. The Zoo has a single adult breeding pair of emus (*number 6 on map*), but the breeding pattern is similar with one female.

In early 1974, when the emus began to enter breeding condition the female appeared to vocalize more frequently than she had before. The female emu has a large, inflatable sac in her throat; and she uses it to produce a deep thumping or booming call. When courtship began the two would stand next to each other and lower their heads close to the ground. Then they would sway their heads from side to side. Finally the female would sit down; more correctly she was resting on her heels, since birds walk on their toes and the backward bend in the leg is not the knee but the heel. The male would sit beside her and then maneuver himself onto her back, taking hold of the skin of her long neck with his beak. During copulation he uttered low-intensity squeaking and purring sounds. Afterwards he stood up and ran away while the female remained sitting.

The male dug a shallow scrape in the ground as a nest and the female began to lay. Bird House personnel removed the first three eggs from the nest and placed them in an incubator. Thus it was hoped that, even if the male was less than diligent in incubating the clutch, some emu chicks could be hatched and raised. These three eggs were laid one a day between February 18th and February 20th; the egg laid on the 19th proved infertile, but the other two were good. After the first three eggs were removed, the curator decided to allow any subsequent eggs to remain with the male. The female continued to lay daily until the clutch in the nest number eight eggs. When these eggs were tested for fertility a month later, only two proved to be fertile. Apparently, while the female continued to produce eggs, the male had lost interest in copulating with her, and thus fertilizing the eggs, soon after he had begun incubating. The eggs were dark green in color, over five inches in length, and about three inches in width. They weighed about a pound and a half each.

In the wild the incubation period of emu eggs can vary greatly—between 25 and 60 days according to one account. The male must leave the eggs from time to time in search of food and water; and—depending on the success of each of his foraging expeditions—he may spend varying amounts of time off the nest. Under the more controlled conditions of an artificial incubator, there is greater uniformity. The eggs placed in the incubator on February 18th and 20th both hatched on April 5th, for incubation periods of 44 and 42 days respectively. When the eggs that the male himself incubated were tested for fertility, the two fertile eggs were also placed in the incubator for hatching; they hatched on April 6th and April 7th. The incubation period could not be measured in these cases, since it was not known when the eggs were laid.

These two eggs were removed because it was believed that the young would stand a much greater chance of survival if hand-raised than they would if they remained with the father. In the wild a male emu teaches his offspring to feed by example. The chicks can walk within 24 hours after hatching and instinctively follow the male from the nest. As he captures insects on which to feed, the chicks begin to peck at them and capture them too. But in a zoo enclosure not enough insects would be available, and the same type of learning by imitation would probably not be effective with the adults' pelleted feed. Moreover, the pellets in which this commercially produced feed is packaged would have been too large for newly hatched emus. When young emus are hand-reared, on the other hand, patient keepers can use a number of strategems to induce the chicks to feed.

Recently hatched chicks of the Burmese red junglefowl (*Gallus gallus*)—the species ancestral to the domestic chicken—were placed with the

emu hatchlings in the hope that feeding by the junglefowl would be imitated by the emus. Also a special starter feed was prepared. First the commercial ratite pellets fed the Zoo's adult emus were ground up. Then a soft, meat based commercial bird-of-prey diet and the ground ratite diet were rolled into little balls. The bird-of-prey diet was more important in holding the feed together in a form in which it would be readily pecked at and eaten than for any dietary value of its own.

For three days Bird House personnel spent hour after hour throwing the balls of feed into the emu and junglefowl chicks' pen. Young junglefowl have a strong innate tendency to peck at any small moving object. In the wild this instinct leads them to peck at insects stirred up by the mother; and, since the mother often takes seeds or other food items and drops them before the chick, the same instinct leads them to peck at these food offerings. Thus the chicks gradually learn, presumably by associating taste with appearance, which small objects are acceptable as food. When the balls of feed were thrown into the pen, the junglefowl chicks would peck at them and soon learned to eat them. Finally the emu chicks, whose instinct to peck at potential food items appears to be less strong than that of the junglefowl, began to imitate the junglefowl and take the feed. After they had learned to accept it, they were gradually switched to a straight ration of ground ratite diet.

The four chicks were weighed daily for about the first two weeks of life. Their weights varied between 13 and 16 ounces on April 9th; by April 25th, their weights varied between 2.5 and 3.3 pounds. Thus, over this period there was an average gain of about one ounce per chick per day. For the next month, weights were taken about once every two days; and by May 29th the chicks' weights varied between 11.7 and 12.8 pounds. Over this period there was an average gain of over four ounces per chick per day. These detailed weight records will provide an invaluable reference in the future. This year's four healthy young emus will provide a

**An emu chick's powerful feet, well adapted for a terrestrial life.**

**Left: an emu chick in its first brown-and-buff-striped plumage at the age of about three weeks. Right: in the second, gray plumage at the age of two-and-a-half months.**

standard for other emu chicks, so that their keepers will be able to measure their progress and detect any deficiencies early, before serious symptoms appear.

The emu chick's first plumage was dark brown striped with pale buff. Like the striped and mottled plumages and coats of many young birds and mammals, this plumage presumably functions as camouflage in the mixed light and shadow of thick grass or other short vegetation. Now, although still faintly striped, the chicks' basic coloration is close to the grey of the adults. Currently the four young emus are located in a yard behind the Zoo's pheasant, crane, and ratite line (*number 6 on map*); they are visible, however, from the Friends of the National Zoo Safari Train. Later, if suitable space becomes available, they may be moved to a yard from which they can be seen by visitors on foot.

There was once another species of emus, the black emu, found only on two islands off the southwest coast of Australia; but soon after the arrival of Europeans, the black emu was driven to extinction. The surviving emu species, though exterminated on the island of Tasmania and vast portions of Australia, is not at present in danger of extinction. However, as with much of Australia's unique wildlife, there is cause for concern. Emus have been accused of drinking the water and eating the grass needed by sheep and cattle in arid parts of Australia, of stamping down wheat-fields, and of eating wheat and other grain crops. Little recognition has been given to the fact that emus destroy large numbers of insects harmful to crops. Recently a campaign was begun in the huge and sparsely settled state of western Australia to exterminate all emus except for those living in a small protected area in the southernmost tip of the state. In a more humane effort at control, a fence many hundreds of miles long was built to keep emus away from wheat and sheep farming regions in West Australia. In view of the apparent unwillingness of man to coexist with emus in much of their native land, the success that our National Zoo and some other zoos have recently had in breeding and rearing emus in captivity is heartening.

# ZOO NEWS
# Mammals

## Tree Kangaroo Joey

Visitors who have seen the short, sparsely furred tail of the Zoo's latest born Matschie's tree kangaroo curling from the opening of its mother's pouch may have wondered what they were seeing. They may also have seen the mother perched behind a rafter in the tree kangaroos' new Reptile House enclosure (*number 19 on map*) carefully grooming the inside of her pouch with her tongue and not realized that she was keeping it meticulously clean for her infant. This infant—or "joey" as the young of tree kangaroos and other kangaroos are known—is the first to be born since the popular tree kangaroo group moved from their former home in the old Lion House. Its paw was first seen out of the pouch on May 3rd, and its head and upper half of its body were emerging regularly in mid-June. By the end of June the joey began to leave the pouch briefly.

The tree kangaroo joey, like the young of other marsupials, is born in an extremely undeveloped state. It weighs only a fraction of an ounce and is blind, deaf, and hairless. The only features that show any great development are the forearms and the sense of smell, and on these the newborn tree kangaroo must rely to make its way directly after birth from the vaginal opening to the mother's pouch. It makes the journey without aid from the mother, climbing through her fur by means of its powerful forearms and guided by its sense of smell alone. When the infant reaches

Matschie's tree kangaroo with an infant in the pouch; the young female at right is showing interest in the most recent addition to the Zoo's tree kangaroo society.

the pouch, it takes hold of one of the four teats there with its mouth and remains attached for several months. The gestation period in all marsupials is short compared to that of placental mammals—only about 32 days in Matschie's tree kangaroo. Most development takes place in the protection of the pouch.

Matschie's tree kangaroo (*Dendrolagus matschiei*) is native to the Huon peninsula in eastern New Guinea. It is one of five species of tree kangaroo found on New Guinea and in northern Australia. All are relatives of the familiar terrestrial kangaroos that have adapted to an arboreal life in tropical forests. Both arboreal and terrestrial kangaroos comprise the family Macropodidae; the name, meaning "big-footed," accurately describes their most striking anatomical characteristic, the greatly enlarged hind feet. The terrestrial kangaroos, as is well known, use their powerful hind feet in long overland leaps. The feet of the tree kangaroos are smaller relative to body size than those of other kangaroos and are equipped with rough-skinned cushion-like soles to prevent slipping from branches. They are used in rather clumsy short hops along vertical branches and along the ground. But they also function to propel the tree kangaroo in its great leaps—up to 30 feet—from branch to branch. The terrestrial kangaroos use the tail as a prop or "third leg" to support the animal while at rest; by contrast, the tree kangaroo's tail, since it hangs straight down below the branch during climbing, lowers the animal's center of gravity and thus steadies it. It also performs a rudder-like function during the tree kangaroo's leaps.

Matschie's tree kangaroo is a social species, living in groups that consist—like the Zoo's tree kangaroo group—of a single fully adult male, several adult females, and their offspring. As with one juvenile male in the Zoo's group, younger males are tolerated by the dominant male. Most members of this small society show great interest when one of their number has a joey in the pouch and may open the pouch to inspect the infant by scent or to groom it.

## New Rodent Exhibits

More than half of the mammals now living are rodents. The number of species included in the rodent order is more than are found in all other mammalian orders combined; and although there is no way of reliably estimating the number of individuals in so vast an assemblage, it is believed likely that here too the rodents exceed all other orders combined. There are rodents on virtually every land surface where mammals are able to live; and there are few habitats—with the notable exceptions of the airways and the oceans—that they have not adapted to occupy. Yet, in spite of their near omnipresence and their staggering numbers, rodents differ remarkably little from one another in basic structure.

All rodents are primarily vegetable feeders, with incisors adapted for gnawing. There are two upper incisors and two lower incisors in every species; and to compensate for wear, the incisors grow throughout life. Growth takes place at the base, and the tooth is continuously being pushed out of the jaw in the form of an arc of a true circle. The outer surface of the tooth is harder than the inner surface, so that the two are worn down at slightly different rates. Thus the tooth is to some extent self-sharpening.

Two new exhibits at the Small Mammal House (*number 15 on map*) show examples of some of the world's many rodent species. In one (cage #47) are one male and three female degus (*Octodon degus*) and in the other (in the nocturnal room) are two male naked-tailed tree-rats or climbing rats (*Tylomys nudicaudatus*). Both are South American species and at first glance both may look a bit like common rats. A closer look, however, will show obvious differences. The degu's tail, unlike a rat's, is covered with fur that forms a tuft at the tip; and its head resembles a guinea pig's more than a rat's. The climbing rat has large hands and feet with rounded pads on the digits—an adaptation for climbing. The degu differs markedly from this arboreal rodent in habits; it is a burrowing species that lives in large colonies.

The house mice and common rats—those persistant rodent pests and camp-followers of man—are of Old World origin. In the New World there is a quite distinct group of native rats and mice, and the naked-tailed tree-rat is one of the many species that comprise it. The degu belongs to another characteristically New World group of rodents—the caviomorphs. This group includes the familiar domestic guinea pig and such sizable rodents as the paca, *Cuniculus paca*, which is also on exhibit at the Small Mammal House (cage #33).

## New Guinea Native Cat

A recent addition to the Small Mammal House collection (*number 15 on map*) is a male New Guinea "native cat" (*Dasyurus albopunctatus*). Somewhat smaller than a house cat, this white-spotted mammal is not, in fact, a cat but a carnivorous marsupial. The carnivorous marsupials belong to the family Dasyuridae, which contains some 50 species ranging in size from a tiny shrew-like form that is the smallest of all marsupials to the wolf-like thylacine. The family also includes the famous Tasmanian devil (*Sarcophilus harrisi*). The "native cats" or dasyures comprise five species of small predators from Australia and New Guinea that reminded early European settlers of the true cats both in habits and their general appearance.

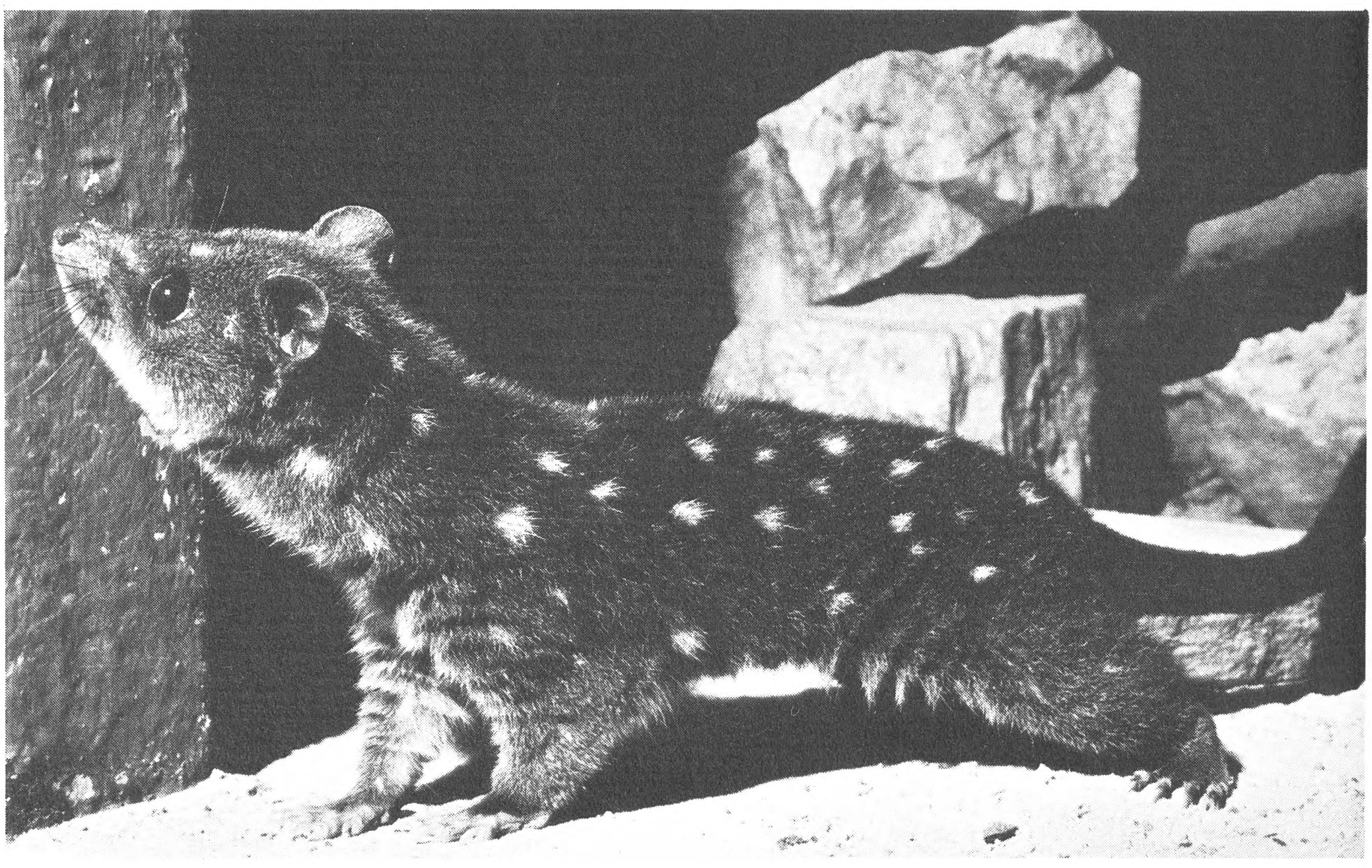
Many of the marsupial carnivores have evolved a superficial resemblance to the true carnivores—a more advanced group of placental mammals. This process—whereby unrelated animals come to resemble one another by adapting to similar ways of life—is known as convergent evolution. Actually the dasyures resemble the placental civet family, the viverrids, more than they do the cats. Little is known of the New Guinea "native cat's" habits in the wild. It is nocturnal and sleeps during the day in a nest of dry grass, leaves, and similar material under a rock or in a hollow log. It spends most of its time on the ground but can climb well.

## Mammal Notes

Spring births among hoofed mammals include a bongo (*Boocercus eurycerus*) (*number 3f on map*), a scimitar-horned oryx (*Oryx dammah*) (*number 8c on map*), and three sable antelope (*Hippotragus niger*) (*number 3e on map*). . . . Two female red kangaroos (*Macropus rufus*) have young in their pouches (*number 9i on map*) . . . . Four Utah prairie dogs (*Cynomys parvidens*) were born in late March and are now visible above ground (*number 17 on map*).

In May two female scimitar-horned oryx became the first animals to be sent to the National Zoo's new Conservation Center, which will be used to breed animals—particularly endangered species like the scimitar-horned oryx—in greater numbers than would be possible in the limited space available in the Zoo.

**New Guinea dasyure or "native cat."**



# Birds

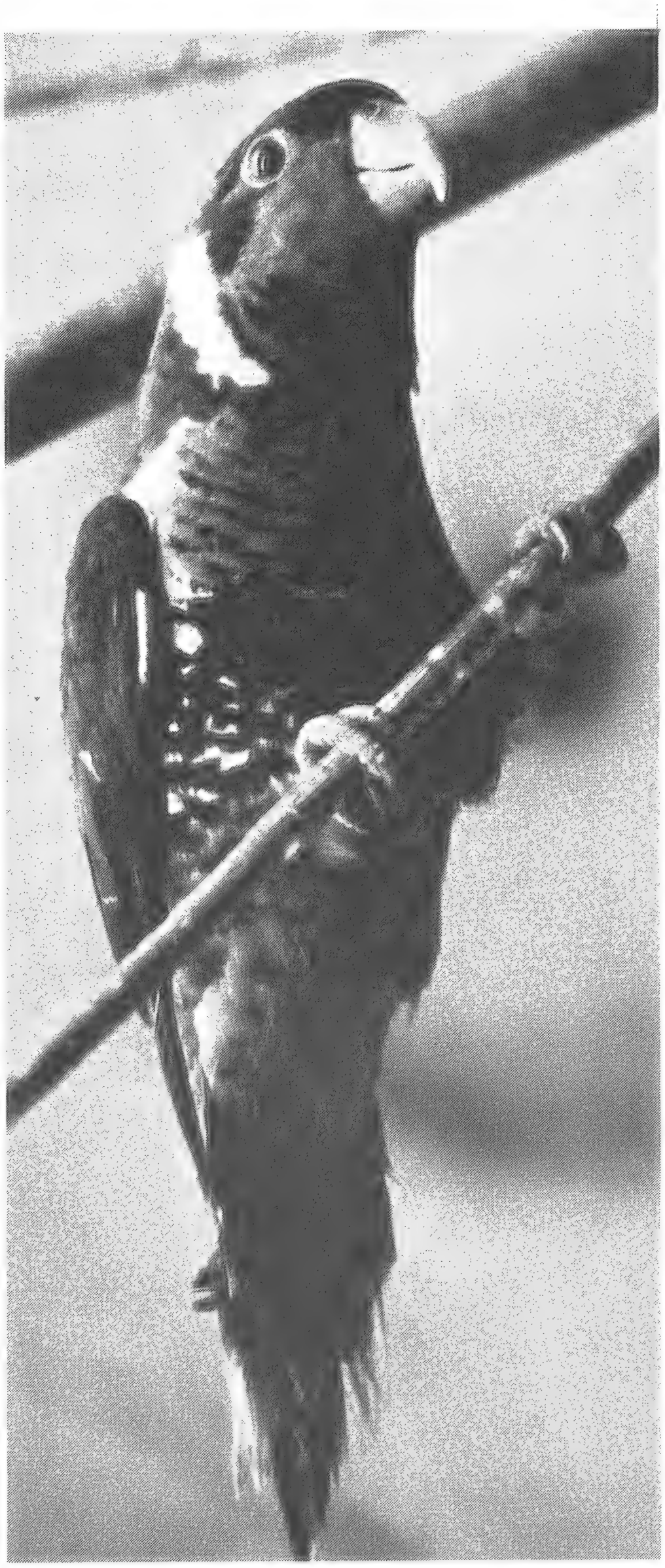
## New Lorikeet Species

The brightly colored lorikeets are the clowns of the parrot world. Not only are the multi-colored feathers of some species reminiscent of motley, but these parrots appear to be quite playful in disposition. Two species recently acquired at the Bird House (*number 5 on map*) provide excellent illustrations. These are the ornate lorikeet (*Tricholglossus ornatus*) and the red-collared lorikeet (*Trichoglossus haematodus*) in cage #3, immediately to the left of the front door of the building. The former species is basically green with the top of the head dark blue; the nape, cheeks, throat and breast red and blue; and yellow streaks at the side of the face. The latter species is still more spectacularly colored; its head is blue, its nape is red, its upper back is black, its lower back is green, and its abdomen and legs are yellow.

There are two birds of each species on exhibit, and the members of each pair frequently engage in playful tussling with each other. In another example of apparent playful behavior, one bird may occasionally fly over the wire front of the cage and, clinging to the wires with its feet, slide down the wire to the bottom of the cage. Examples of genuine play behavior, frequently found in mammals, particularly in the young, are hard to come by in birds. But the tendency to play is correlated with the ability to learn. (Man, with his enhanced capacity for learning, also has an apparently enhanced capacity for play and a greater tendency to continue play into adult life than most other animals.) And that play seems to occur with relative frequency in the lorikeets and in certain other parrots is not surprising in view of the parrots' apparently higher learning abilities relative to those of most birds.

The red-collared lorikeet belongs to a widespread species found in much of Indonesia, New Guinea, and northern Australia, while the ornate lorikeet is found on the large Indonesian island of Celebes and a few surrounding smaller islands. Another, somewhat less brilliantly colored lorikeet species—the Mount Apo lorikeet (*Trichoglossus johnstoniae*)—has also been acquired recently and is being exhibited in the turquoise parakeet cage on the rear wall of the Bird House. This species is notable for its rarity; it is apparently restricted to Mount Apo and a few other mountains on the island of Mindanao in the Philippines, living only between the altitudes of 4000 and 8500 feet above sea level.

**Collared lorikeet at the Bird House** (*number 5 on map*).



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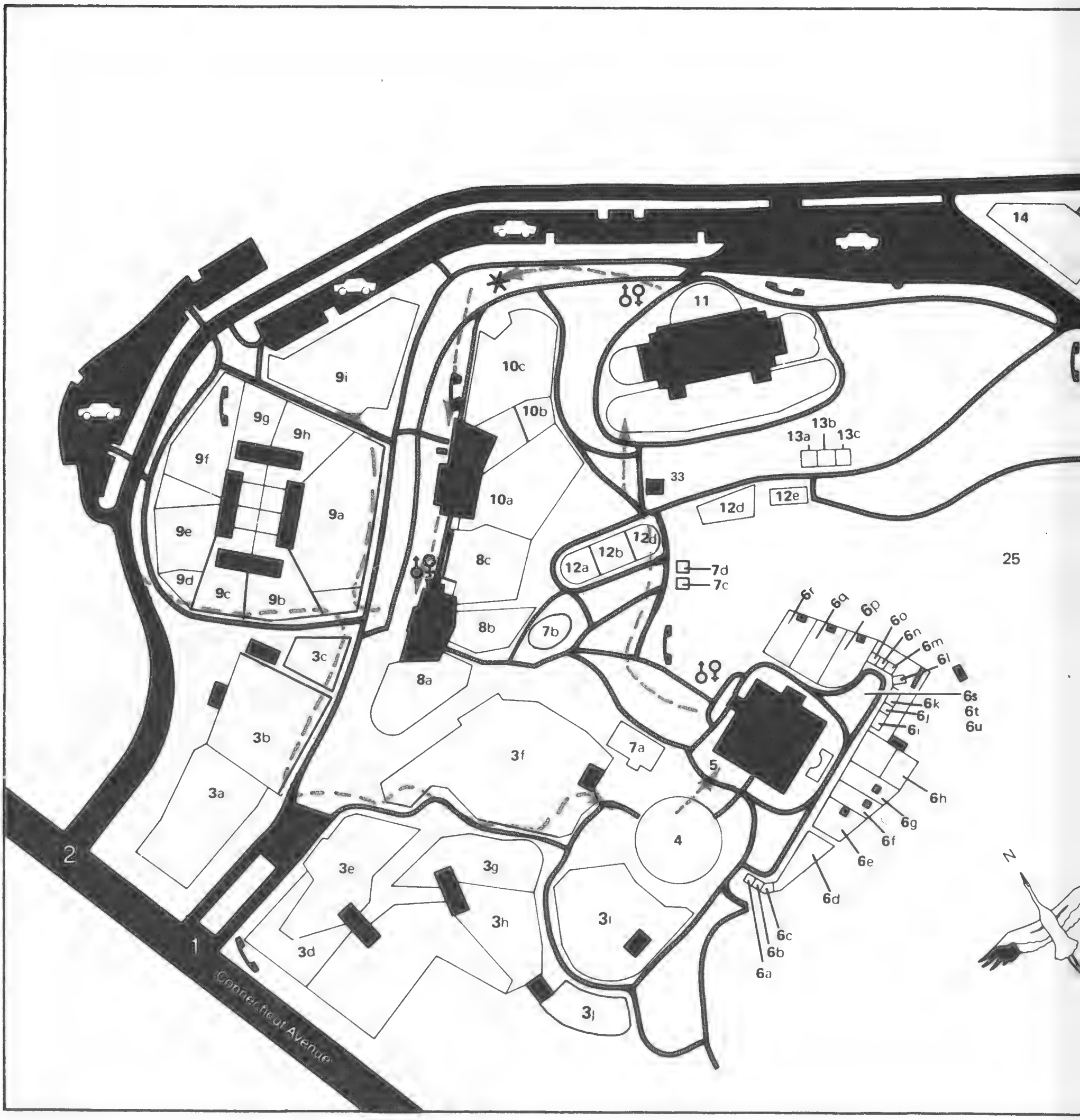

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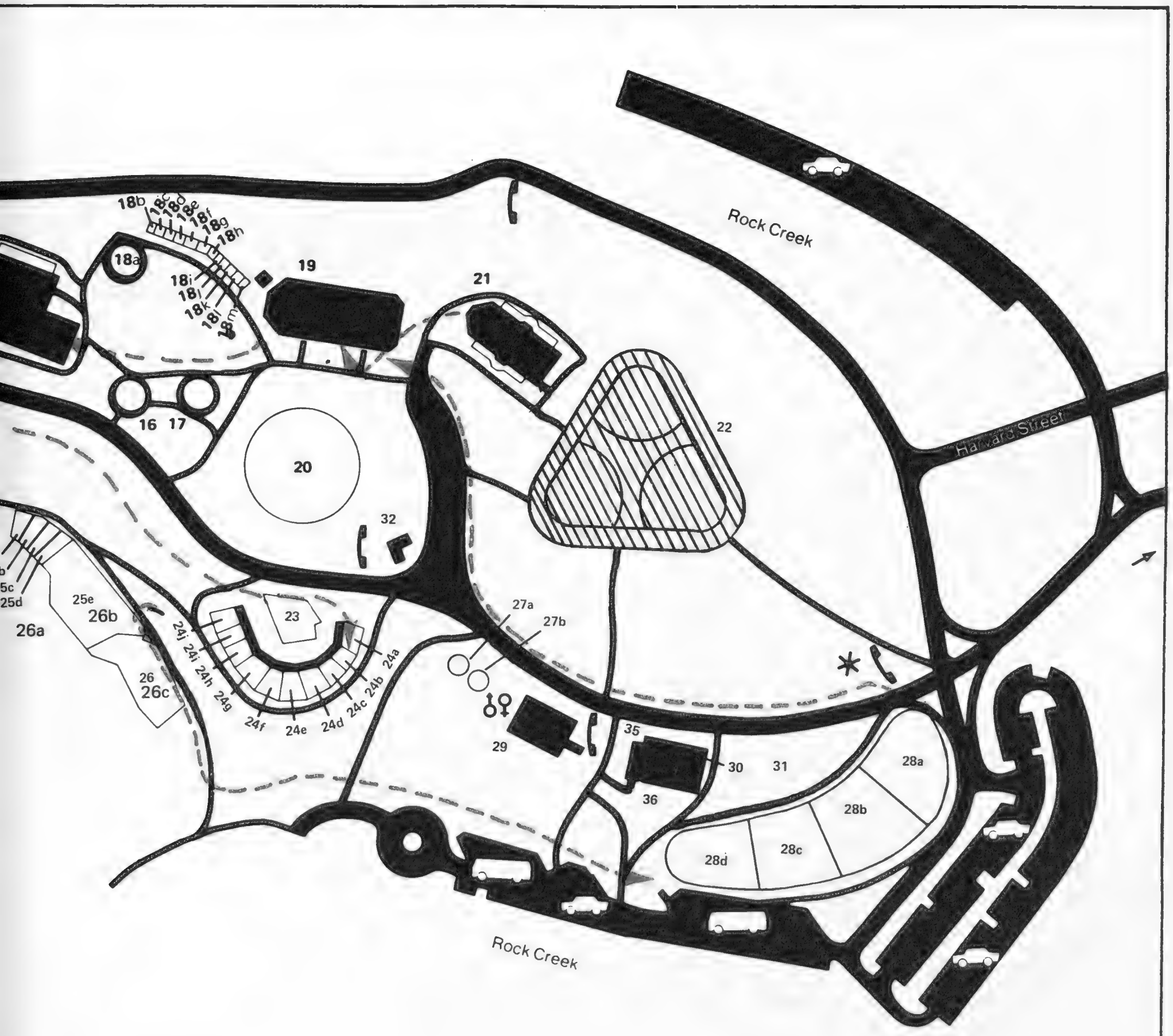

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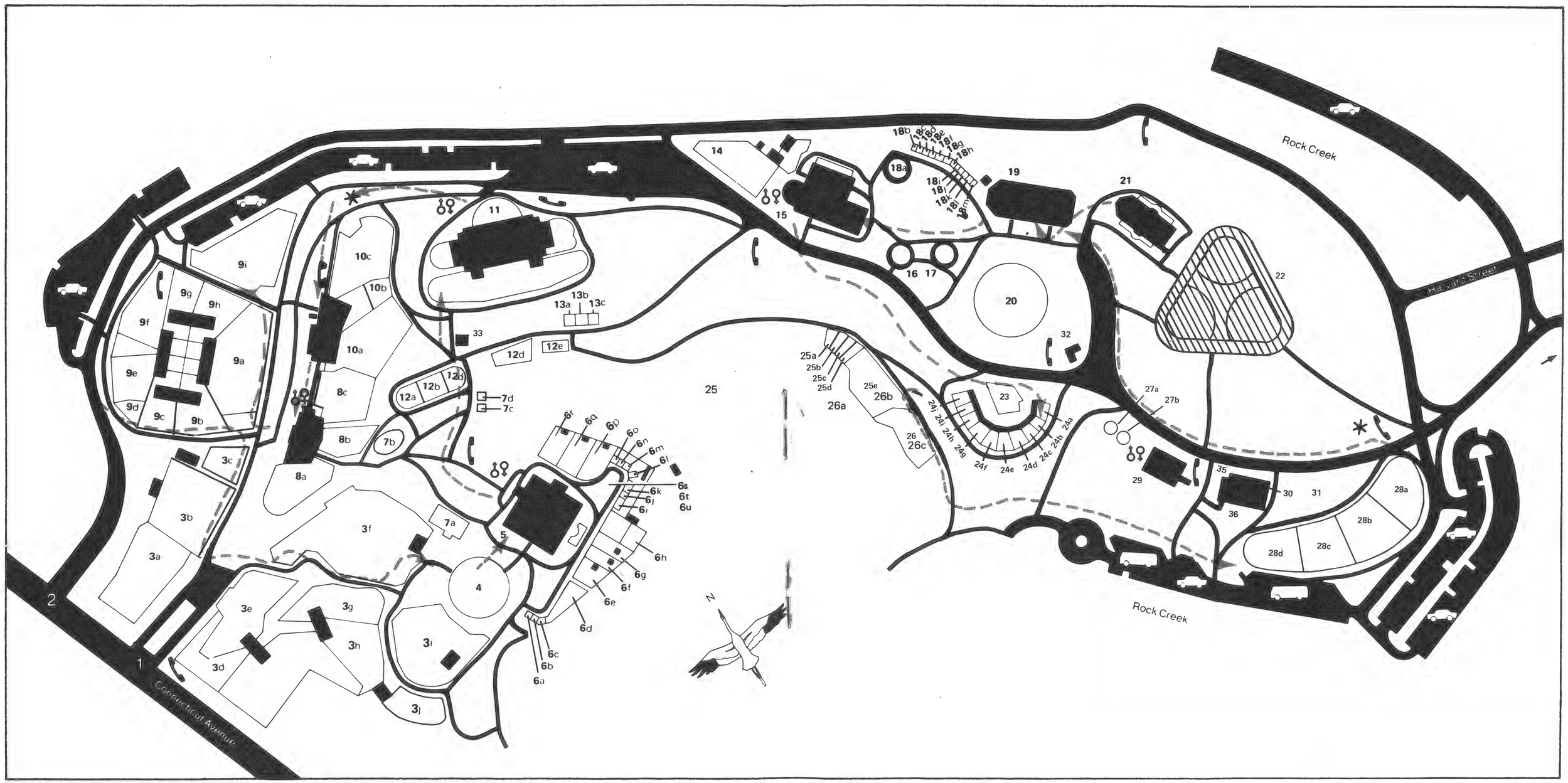


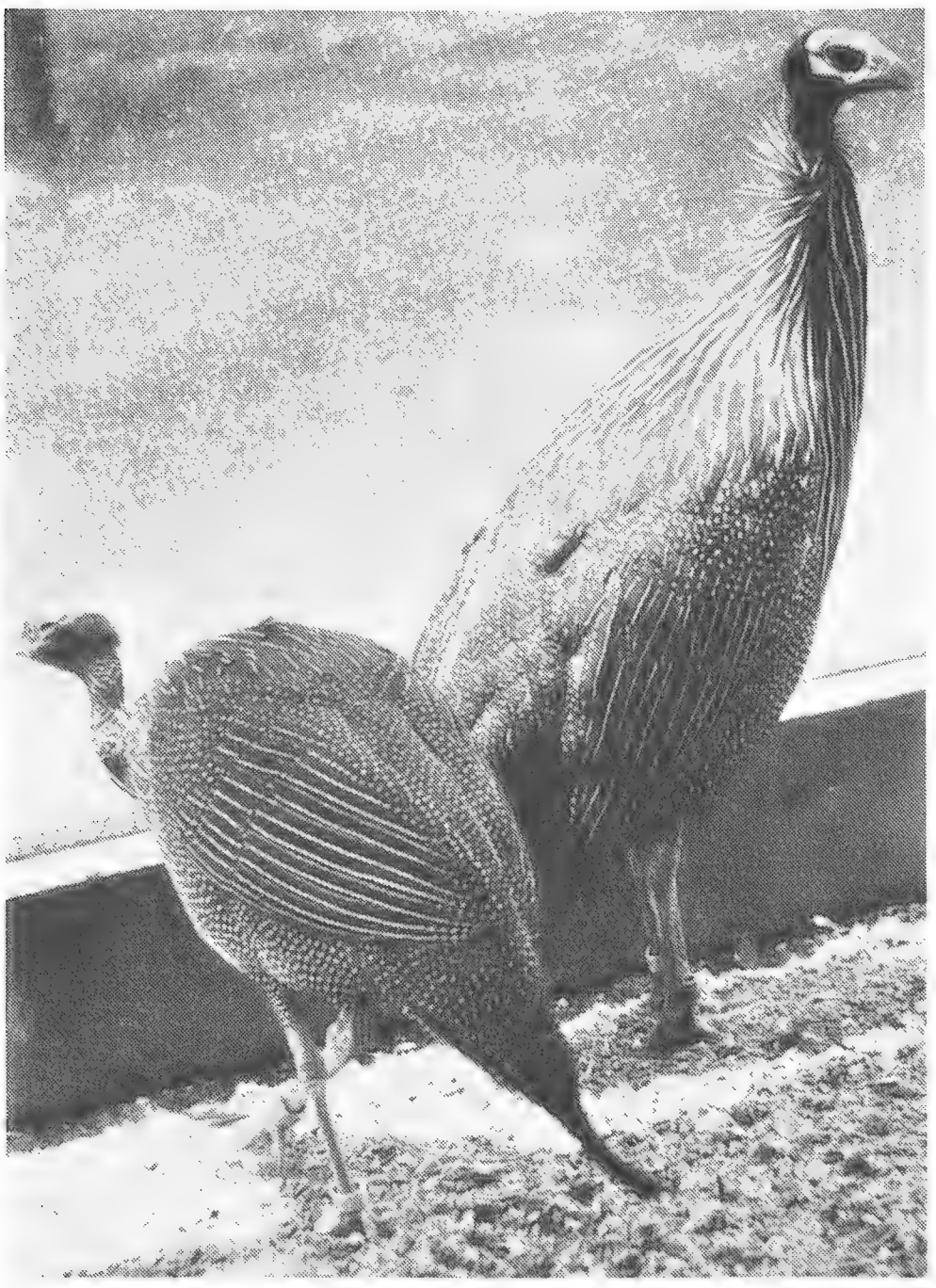
## Vulturine Guineafowl

Recent additions to the Bird House collection include four vulturine guineafowl (*Acryllium vulturinum*), two located in the open-fronted enclosure to the right of the front door of the building (*number 5 on map*), and two in the Great Flight Cage (*number four on map*). Native to Africa south of the Sahara and Madagascar, the guinea-fowl form a group of six species of gallinaceous birds—that is, birds related to the chickens and pheasants. This particular species inhabits the dry steppes of East Africa from southern Ethiopia and Somalia to northeastern Tanzania. Its name derives from the fact that, like that of a vulture, its head is bare of feathers. It is by no means a scavenger, however, but feeds mainly on seeds and insects.

Guineafowl were domesticated by the Greeks and Romans but disappeared in Europe early in the Christian era. The helmeted guineafowl (*Numida meleagris*) was brought back from the Guinea coast by the Portuguese in the Fifteenth Century and domesticated. It still survives as a domestic species, but it has never proved as popular as the chicken or the turkey because of its monogamous life-style and because of its relatively low egg-yield per hen.

Vulturine guineafowl are also monogamous. Each pair constructs a simple nest by digging a hollow in the ground and lining it with trampled grass. The nest is usually concealed in tall grass or among rocks and bushes. The hen lays eight to 15 pale cream or buff eggs with brown and white specks and incubates them 24 days. After the breeding season, vulturine guineafowl form large flocks in which there is apparently a dominance hierarchy or "peck order." In a conflict the dominant bird lunges at the lower-status bird with its head lowered and wings raised over its back.

**Vulturine guineafowl.**



## Bird Notes

A pair of hoopoes (*Upupa epops*) have eggs in the large cage to the right of the front door of the Bird House. . . . The Zoo's female Andean cock-of-the-rock (*Rupicola peruviana*) has shown signs of building a nest in a closet that opens onto the indoor flight room at the Bird House. In the wild this species nests in cave entrances, and the closet may prove an acceptable substitute. . . . Among many species hatched in the incubators in the Bird House basement this spring, some of the most notable were Inca terns (*Larosterna inca*) and Swinhoe's pheasants (*Lophura swinhoei*). The former species, from the coast of Peru, has not been bred at the National Zoo before; the adults are located in the great flight cage (*number 4 on map*). Swinhoe's pheasant (*number 6-1 on map*) is close to extinction on its native Taiwan.

# Reptiles and Amphibians

## Smooth-Fronted Caimans

Three smooth-fronted caimans (*Paleosuchus trigonatus*) have recently been placed on exhibit in cage B-3 at the Reptile House, the rear cage on the crocodilian line. The caimans are South American relatives of the alligators and crocodiles. This species does not reach anywhere near the great size of some of its better known relatives, and adults range between 3 and 5 feet in length. The Zoo's specimens are young and less than 2 feet long.

The crocodilians—the alligators, crocodiles, caimans, and gavials—are an ancient order of reptiles, which had fully evolved by the beginning of the Jurassic Period of the earth's history, some 180 million years ago. This was relatively early in the age of dinosaurs; and the crocodilians are related to the dinosaurs, being in fact their closest relatives now living. Together with the dinosaurs they are grouped in a major subdivision of the reptile class known as the subclass Archosauria—the "ruling reptiles." Members of this group did rule the earth in the later Mesozoic Era, but now all save the crocodilians have vanished.

The Zoo's three spectacled caimans, their eyes just above the water line.

However, some of the smaller ruling reptiles were ancestors of the birds; and in this class—most successful of vertebrate classes in number of species and subspecies—the ruling reptile line has left an important mark on the current world fauna.

The crocodilians probably owe their persistence to the fact that they have perfected more than any other reptiles before or since the role of relatively large predators in inland waters. One disadvantage for reptiles assuming an aquatic life was that in primitive reptiles the nasal passages opened directly into the front of the mouth, endangering breathing if the mouth was opened under water. But the crocodilians have evolved a bony partition that separates the nasal passages from the mouth so that they open into the throat behind a flap of flesh at the back of the tongue. This flap can close off the air passages so that, with the nostrils above water, the crocodilian can continue to breathe even when its mouth is open below the water line, as it is when the crocodilian is capturing or holding onto prey in the water.

It is interesting to note how many characters the crocodilians share with other extinct ruling reptiles and with birds. Many of the dinosaurs were bipedal, with long and powerful hind legs and relatively small forelimbs; and it was a similar bipedalism that freed the forelimbs for development as wings and thus allowed for the evolution of birds. Though the crocodilians are quadrupedal, they show the tendency towards longer hind limbs that characterized the ruling reptiles. Like birds, the crocodilians have a four-chambered heart, allowing for much more efficient circulation of blood than the typical reptilian three-chambered heart. Unlike most reptiles, crocodilians guard their eggs until hatching and in the case of some species females have reported to guard the young for some time after hatching. The discovery of one fossil site where dinosaur eggs, young, and adults were found close together has opened the possibility that some dinosaurs also guarded their eggs and young. Thus it may be that the type of parental care so familiar and highly evolved in the birds has roots that extend as far back as the earliest common ancestors of the ruling reptiles.

A further similarity between the crocodilians and the birds is the use of "gizzard stones." A crocodilian's sharp teeth are used for capturing and holding prey, not for chewing; the prey is swallowed whole or in large pieces and is not chewed. But the crocodilian swallows pebbles which lodge in the muscular part of the stomach known as the gizzard, and these aid in grinding up the food; 69 pebbles were once found in the stomach of a smooth-fronted caiman. Many birds too swallow pebbles or grains of sand as gizzard stones.

The smooth-fronted caimans are found in the Amazon basin, a region which contains greater diversity of living crocodilians than any other. They inhabit rocky and swift-moving streams that are avoided by the larger crocodilian species. Interlocking bony shields on the back and belly are believed to be adaptations to protect them from harm when thrown against rocks in rapids. The presence of these plates has apparently made the smooth-fronted caiman's hide valueless as leather—a fortunate circumstance, since hunting for the leather trade is a major reason why many members of the ancient crocodilian order are now in danger of extinction. But no crocodilian can yet be considered safe from needless human persecution and habitat destruction, which affect even species with little economic value.

## Reptile Notes

Recent hatchings at the Reptile House have included several leopard geckos (*Eublepharis macularis*) and a total of 45 Burmese pythons (*Python molurus bivittatus*). . . . Three Asiatic striped ratsnakes (*Elaphe taeniura*) have been placed in a new exhibit in cage C-11. These handsome snakes are Southeast Asian relatives of the black ratsnake (*Elaphe obsoleta obsoleta*) and the corn snake (*Elaphe guttata*) native to the eastern United States.

# Iguana

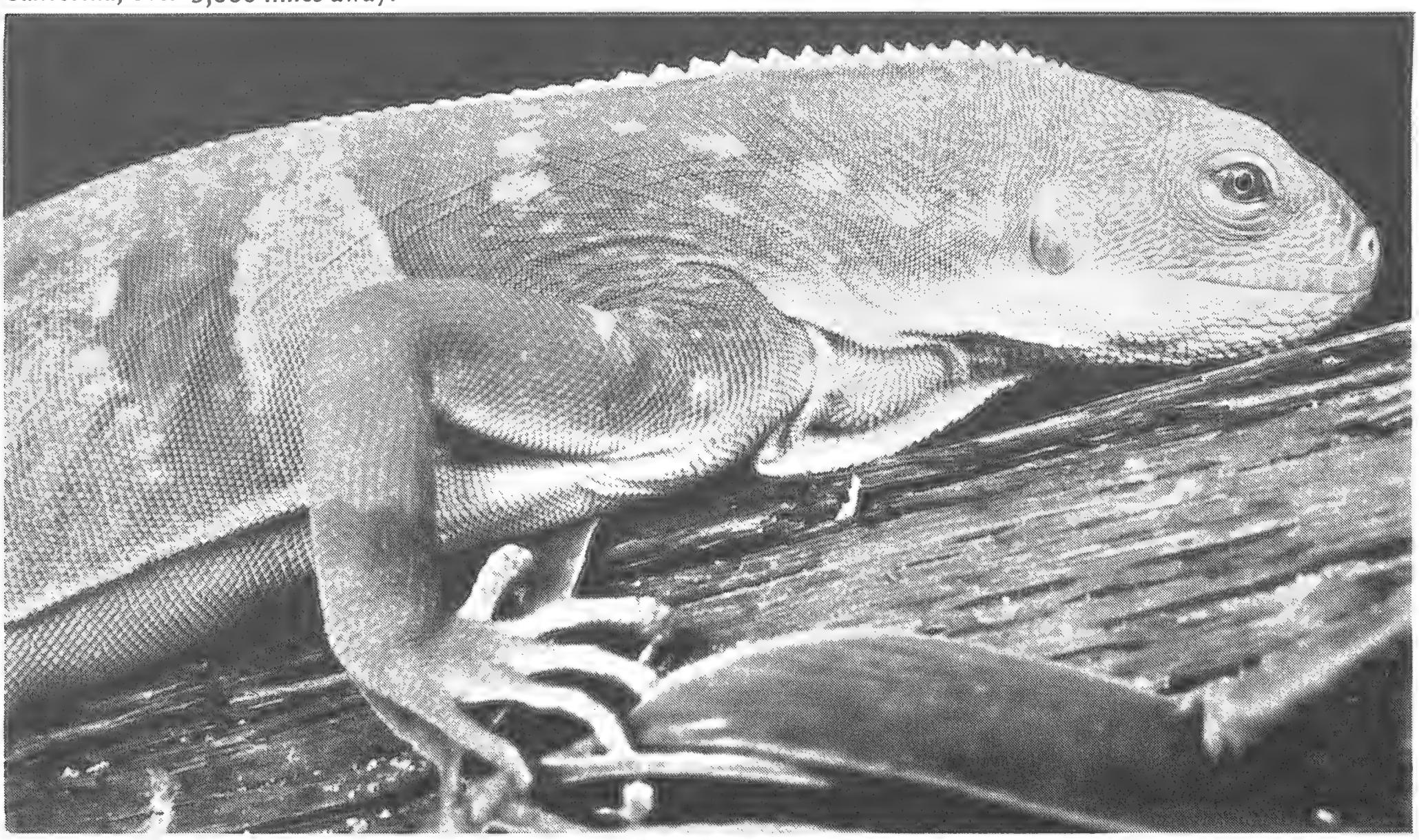
The iguanid lizards (Iguanidae) comprise by far the largest family of lizards in the New World; almost three-fifths of the lizard species found in the United States and Canada are iguanids. The iguanids are not dominant in all parts of our continent, however; only one of the eight species of lizard found in the District of Columbia, Maryland, and Virginia, is of this family—the small brownish Northern fence lizard (*Sceloporus undulatus hyacinthinus*). But for other areas, particularly the Southwest, it can be said that any lizard encountered is more likely than not an iguanid; of thirty-six species recorded for lizard-rich Arizona, twenty-four are iguanids. And in the Southwest the iguanids are not only numerous but conspicuous, including some relatively large species and species that are more frequently seen by day than are many of our other lizards.

The two species that are probably the most familiar to the general public of all North American lizards are members of the Iguanidae—the Carolina anole (*Anolis carolinensis*) and the Texas horned lizard (*Phyrnosoma cornutum*). Both of these species are frequently sold as pets and are widely known by their misleading pet-store names. The former, because of its color-changing abilities, is sold as a "chameleon," although the true chameleons are exclusively Old World lizards. The latter, because of its broad, flattened body, is often called a "horned toad." These two well known species provide a good illustration of the diversity of external appearance found in the family. The Carolina anole corresponds to the popular conception of a typical lizard, with its slender body and long tail. By contrast, the horned lizard, with its unusual shape and scales that have been modified into spines lining the body and horns on the head, is one of the most bizarre in appearance of all the lizards.

Indeed with some 700 living species the iguanids have invaded a wide variety of habitats and assumed a good many shapes and sizes. The common iguana (*Iguana iguana*) of tropical America is the largest New World lizard; it is reported to reach a length of over six feet, most of which is tail. (Three specimens are on exhibit in cage C-26 at the National Zoo's Reptile House, *number 19 on map*.) Many species are much smaller than this. The Texas tree uta (*Urosaurus ornatus*) averages only slightly over one-and-a-half inches from snout to vent, with a slender two-inch tail.

A few of the iguanids have attracted interest because of their unusual habits. Perhaps the most remarkable is the marine iguana (*Amblyrhynchus cristatus*) of the Galapagos islands in the Pacific. The marine iguana lives in groups on the lava-rock beaches of this volcanic archipelago, feeds on seaweed, and navigates the surf with ease. Another

**The Fiji island iguana (*Brachylophus fasciatus*) lives in surprising isolation in its Pacific island home; its nearest relatives are in California, over 5,000 miles away.**



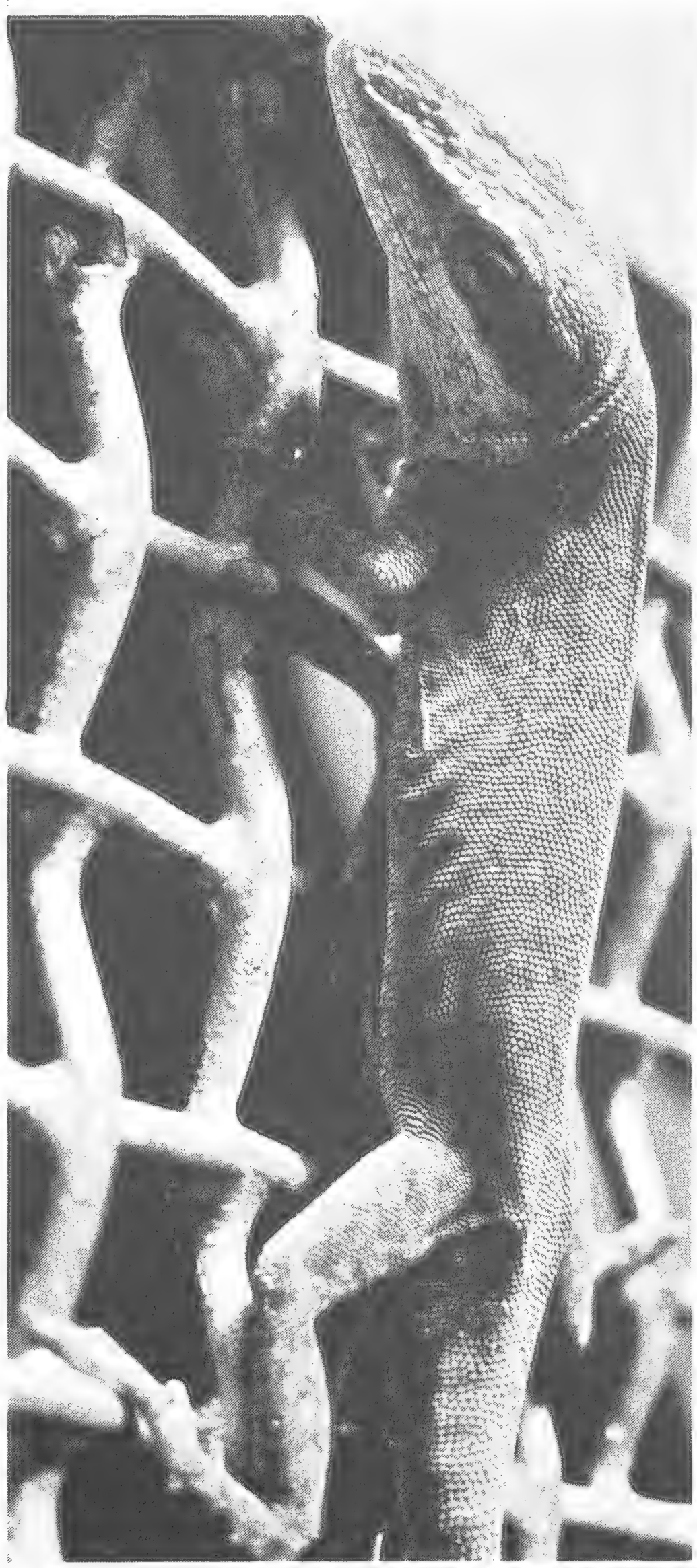
outstanding departure from typical lizard ways is found in the ability of a number of iguanid species to assume an unusual means of locomotion—rearing up on the hind legs to run for a short distance. The collared lizard (*Crotaphytus collaris*) of the western United States is an example. The basilisk lizards of the American tropics (*Basiliscus*) can even run bipedally over the surface of standing water for short distances.

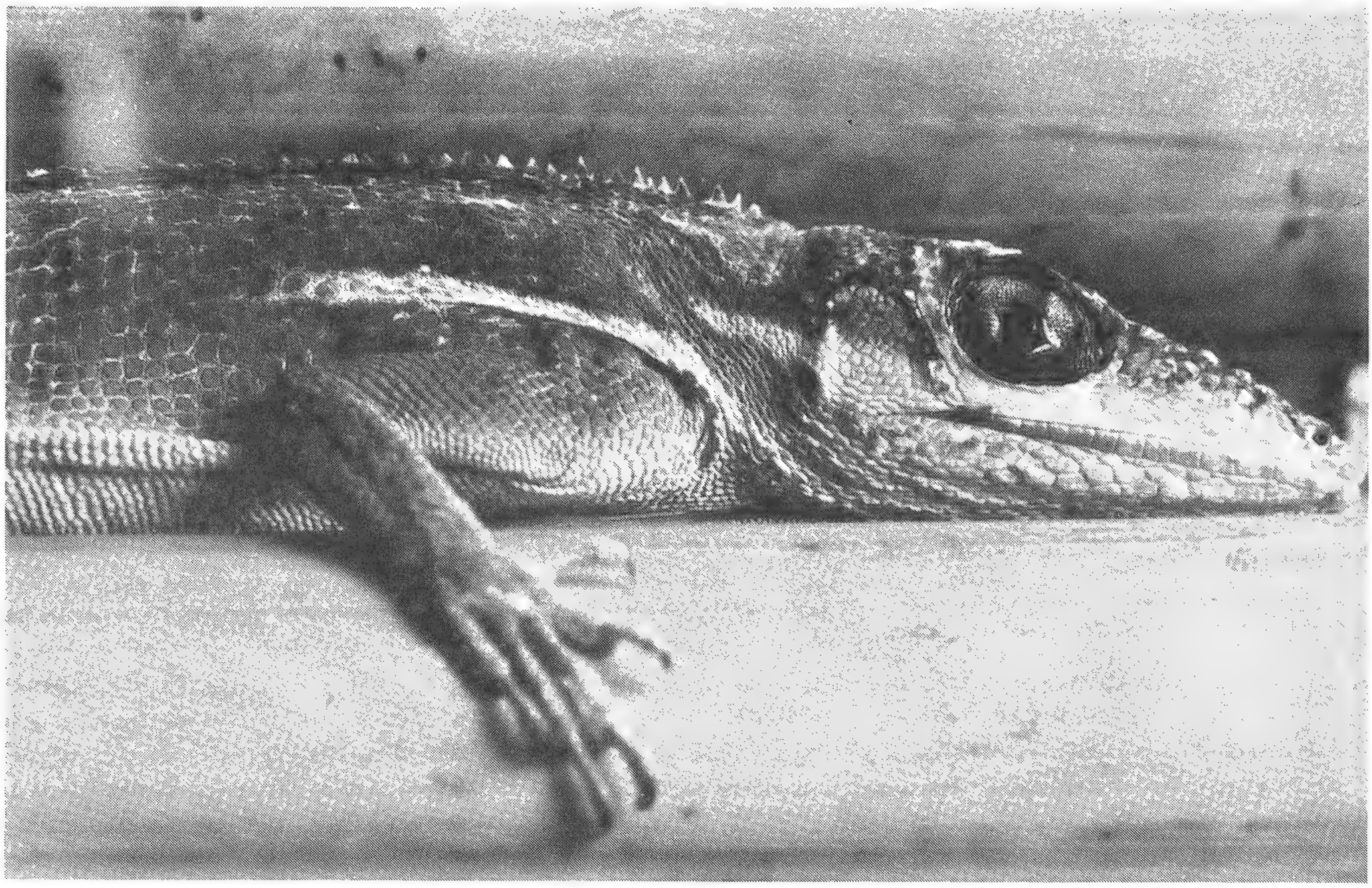
Though the iguanids are so numerous in the New World and form so characteristic a part of its reptilian fauna, a few members of this family appear in surprising isolation in two parts of the Old World. Seven species inhabit Madagascar, and one lives on the remote Fiji Islands in the Pacific. (The Fiji Island iguana, *Brachylophus fasciatus*, is on exhibit in cage E-15 at the Reptile House.) To explain this widely discontinuous distribution has been one of the classic problems of zoogeography—the branch of biology that studies the geographic ranges of animal species and groups and attempts to account for them. The task has been complicated by the fact that so far few fossil remains of early iguanids—and of other ancestral lizard forms—have not been found. Most lizards have been small-boned and have not made the best of fossils; in addition, it has been suggested that, during the great era of fossil discovery in the Nineteenth Century, workers tended to pay more attention to the many giant reptiles of the past at the expense of their less spectacular cousins. In any event, in the absence of a detailed fossil record, scientists can only guess where and when the iguanids originated and how their present pattern of distribution came about. But the guess work itself is often fascinating.

The lizards themselves first appeared, as far as we know, in the Triassic of Africa, some 200 million years ago. The first undisputed iguanid remains that have so far been identified are from the Eocene of North America, about 150 million years later. By that time, however, the Iguanidae were widespread and diversified on this continent; and other lizard families that, on the basis of their physical structure are considered more advanced than the iguanids and would be expected to have evolved later than them, had already made their appearance and spread widely. Obviously the iguanids had existed for some time before the Eocene, but no earlier fossil remains give us a clear picture of the place and time of their origin. If the family originated in North America, it is difficult to explain its occurrence in isolated pockets in the Old World. If it originated in the Old World, the difficulty lies in explaining the means by which it reached the New World and its current virtual absence in the Old World.

In Eurasia, Africa and Australia there exists a family of lizards that is apparently closely related to the Iguanidae and to a certain extent parallels them in the habitats it has invaded and the life-styles its members

**The Carolina anole—sold in pet stores as a "chameleon"—is probably the most familiar of iguanids to North Americans.**





**The knight anole of Cuba (*Anolis equestris*) is named for the helmet-like appearance of its head.**

have evolved. This family is known as the Agamidae, and it would appear to have evolved from the Iguanidae. (An example of an agamid at the Reptile House is the bearded lizard, *Amphibolus barbatus*, in cage A-2.) The two differ most apparently in the structure of their teeth. Iguanids' teeth, like those of most lizards, are similarly shaped throughout the mouth. The agamids are unique among lizards in that their teeth are divided into three types that roughly resemble the incisors, canines, and molars of mammals. It is a curious fact that there are no agamids in the New World or on Madagascar; only in the Fiji Islands do agamids and iguanids live side by side.

As for the Fiji Island iguana, it is conjectured that its ancestors came not from the Old World but from the New. The gradual island-hopping that would have been the normal course by which a lizard species would reach a distant Pacific island group from Asia would almost certainly, it is felt, have left surviving iguanid relatives on some of the islands traversed. Rather it is asserted that the iguanids must have reached Fiji by westward colonization from North America—an ocean voyage of over 5,000 miles. In fact, on the basis of its physical structure, the Fijian species is held to be most closely related to the crested lizards (*Dipsosaurus*) of Baja California and the Southwestern United States. Presumably an ancestral form related to the crested lizards was rafted across the Pacific as far as the Fiji Islands on a tree that fell into the water or by some similar means. All that would have been necessary would have been that such a tree contain a male and a female or even a single gravid female; and reptiles are well able to survive with no or minimal food and water long enough to make such a trip. Similar means must have brough iguanids to the Galápagos, 600 miles from the South American mainland.

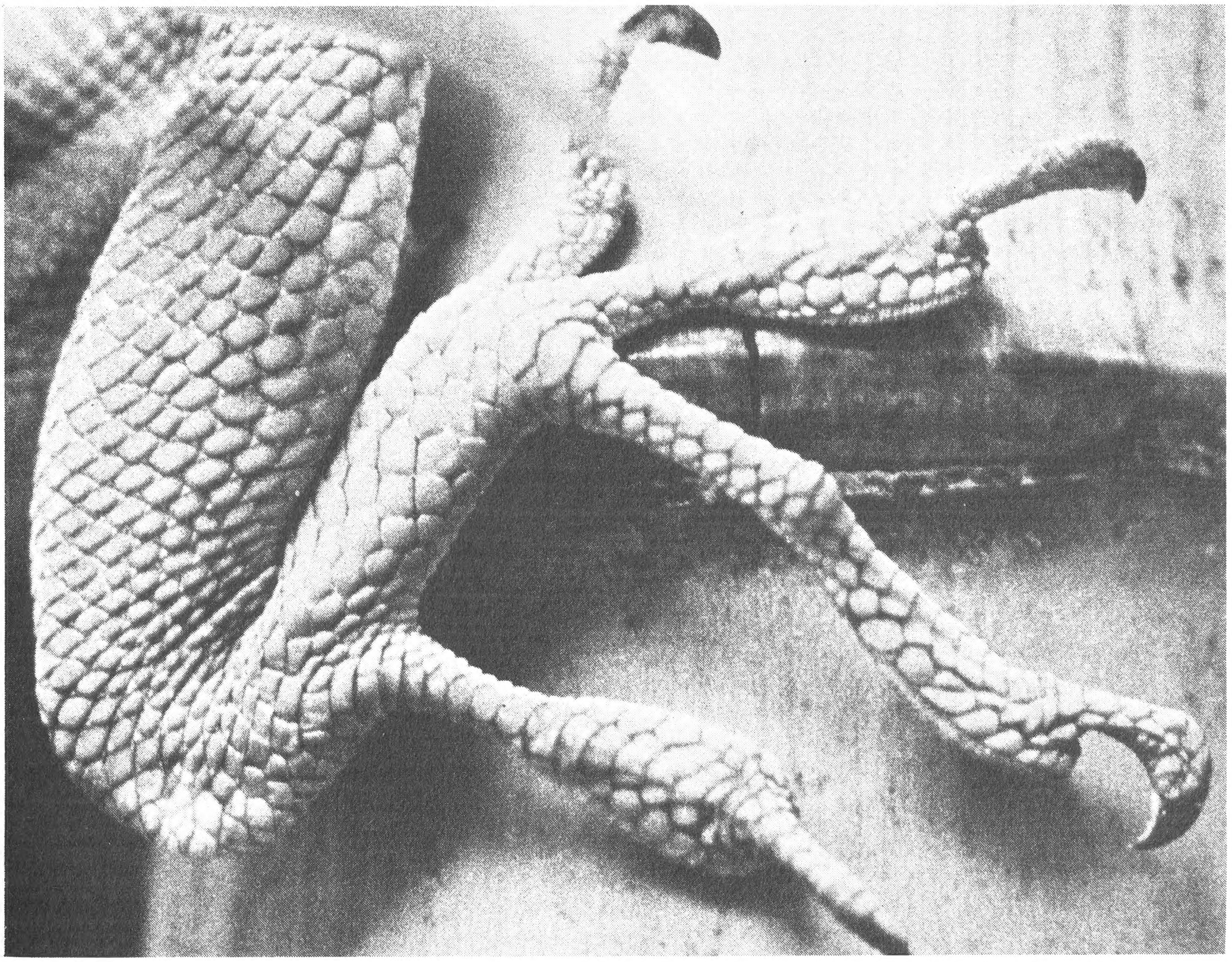
In view of the almost mutually exclusive distributions of these two closely related lizard families, the theory has been proposed that the Iguanids originated in the Old World, probably in Africa, and then, after spreading as far as the New World, were eliminated in their original Old World home wherever they were in competition with the more successful and more recently evolved agamids. Only on Madagascar, by this account, did an iguanid remnant manage to survive; and, since that

island had already been separated from the mainland before the agamids made their appearance, the younger family never reached there. Herpetologists have long considered the seven Madagascan iguanids the most primitive in physical structure of living members of the family; and it is not surprising that they of all living iguanids should have diverged least from the family's hypothetical African ancestors. The Madagascan fauna is well known to include a substantial collection of primitive types whose closest relatives have long since died out on the African mainland.

If the iguanids evolved in Africa, we should expect there to be some fossil species from the Old World. One has been described from Europe; but it is an incomplete fossil, and some authorities assert that it must be an agamid. Moreover, the means by which the iguanids reached the New World before dying out in the Old remains to be accounted for.

One explanation that has been proposed involves an intriguing but still controversial theory known by the curious name of the "Gondwanaland" hypothesis. Certain beds of Permian and Triassic deposits in India—many of them found in a formation called the Gondwana beds—contain plant remains unlike any others found in Asia but closely resembling plants from the same era in Australia, Africa, and South America. As an explanation it was proposed that India, Africa, Australia, South America, and Antarctica were originally joined together to form a southern continent, which was given the name Gondwanaland. At some point, according to this theory, the land masses constituting Gondwanaland broke apart and began drifting to their present positions, the Indian subcontinent eventually colliding with Asia to give rise to the Himalayas. As Gondwanaland apologists pointed out, the eastern coast of South America and the western coast of Africa seem to show a rather neat "fit," as does the south coast of Australia with part of the north coast of Antarctica. The positions of India and Madagascar in the hypothetical assemblage could not, however, be so easily accounted for.

**Foot of the knight anole, showing flattened digits that are an adaptation for the arboreal life characteristic of the anoles.**

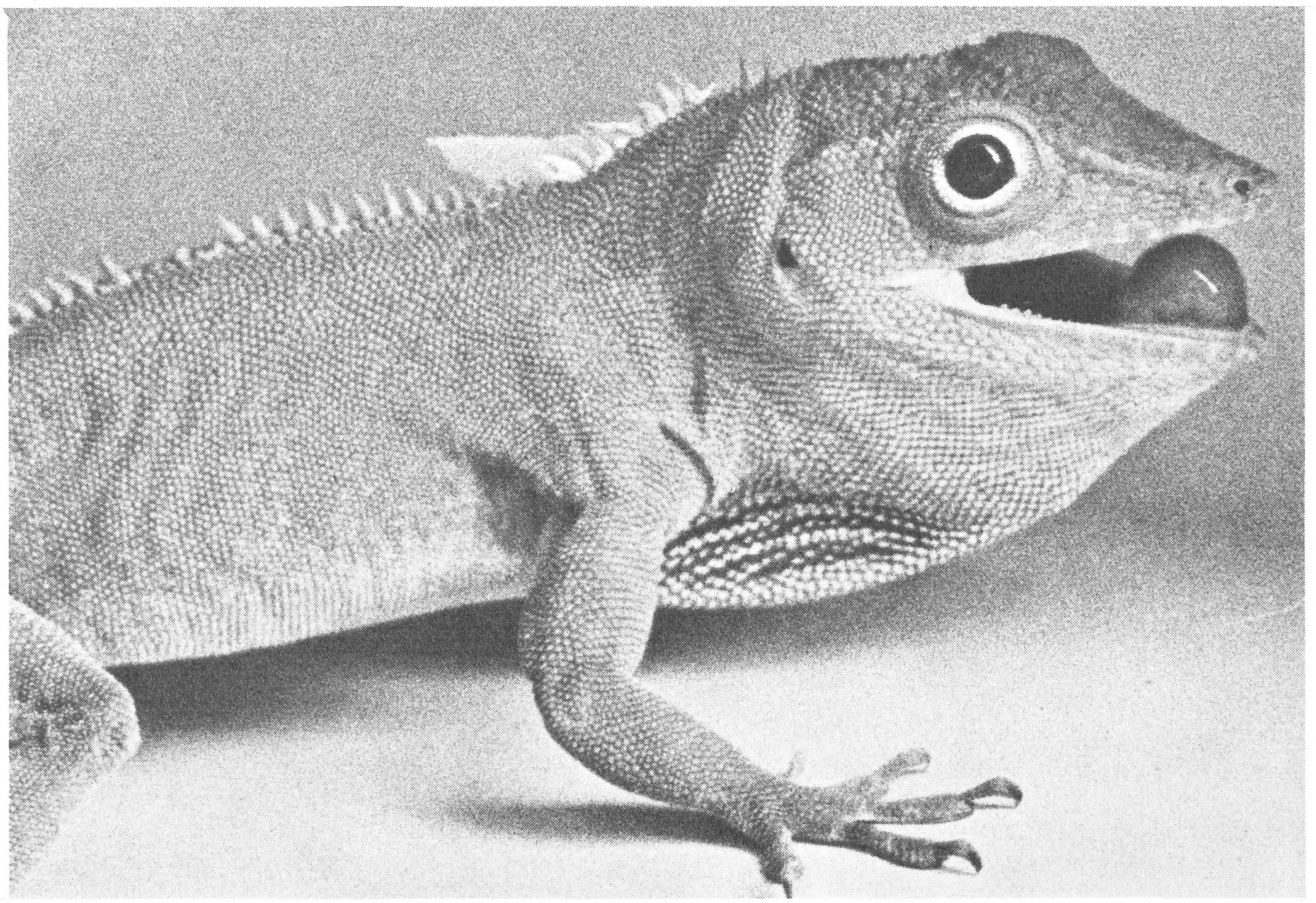


Most geologists tended to discount the Gondwanaland hypothesis when it was first proposed. No theory of continental drift appeared to have more than circumstantial confirmation; but recently the debate has been reopened in the light of striking new evidence. There is a ridge in the center of the southern Atlantic forming an irregular line the shape of which corresponds with those of the coastlines of both South America and Africa. Along this ridge earthquakes occur frequently, and the forces that cause them have been present for millions of years. These forces would have been quite capable of breaking apart Africa and South America, and the ridge is located in exactly the right position for them to have done so. Evidence from this ridge indicates that the separation of the two continents must have begun about 180 million years ago. In terms of animal life this was the Jurassic period, and early iguanids could conceivably have existed then on "Gondwanaland." Thus iguanids may have flourished on the South American section of the former continent, survived on the Madagascan section, and been eliminated by competition on the African section.

Scientists have only recently begun to devote more than casual study to the behavior of the iguanid lizards, but already the results have proved exciting. With few exceptions adult male iguanids are territorial, and each typically advertizes his possession of a territory by displaying in highly stereotyped ways from prominent places. The displays involve nodding movements of the head and "push-up" movements of the front half of the body. When the male encounters another male intruding on his territory, he intensifies these movements to threaten off the trespasser. Territorial defense of this sort plays so important a role in the life of the typical iguanid that the instinctive behavior patterns associated with it are among the first to appear in the newly hatched lizard. Some iguanids only a few months old—often with the yolk sacs that have nourished them in the egg still attached to their bodies—have been observed performing the push-up and nodding movements of adult aggressive display.

The most spectacular displays of territorial male iguanids occur in the genus whose members are known as anoles (*Anolis*). Comprising by far the largest of the iguanid genera, these mostly small, arboreal lizards represent two-fifths of all the species in the family. Only two

**Aggressive display of a male Jamaican anole (*Anolis garmani*). Note the extended dewlap or throat fan; the concentric rings marking it are bright red. The tongue is protruded and fills with engorged blood.**



are found in the United States: the Carolina anole already mentioned and a closely related species found only on Key West, Florida. But in the New World tropics a bewildering variety of anoles has evolved. Nowhere is this diversity more apparent than in the West Indies. Two of the West Indian anoles are on exhibit at the Reptile House—the Jamaican anole (*Anolis garmani*) in cage A-17 and the knight anole of Cuba (*Anolis equestris*) in cage A-18.

The male anole's aggressive display is augmented by the extension of a dewlap of loose throat skin, which is often brightly colored and marked in a way characteristic of the species. In the Carolina anole, for instance, the male's dewlap extends in display to form a bright red disk or fan. Many anoles, including the Carolina anole, also have crests on the nape and upper back that are erected during the display. Also the tongue may be protruded; and in some species it may fill up with blood and assume a deep purple color. Finally most male anoles use their color-changing abilities to further enhance the aggressive display.

The Carolina anole is capable of assuming only two basic colors, green and brown; but each may occur in a number of shades. The male turns a bright green during the aggressive display. Its color-changing, contrary to popular belief, is not a simple matter of camouflage but is influenced by light-intensity, temperature, and—in aggressive encounters—emotional state. Under the transparent epidermis of the anole's skin there are cells containing yellow pigment. Beneath these is a layer of cells that reflect blue light, and still deeper there are cells containing black pigment. When the anole appears green, blue light is being reflected by the reflecting layer through the layer of yellow-pigmented cells. It appears brown when the black-pigmented cells send streams of black pigment into fine processes that extend around the cells of the blue-reflecting layer, thus preventing them from reflecting light.

Aggressive display is essentially a means of communication, warning intruding males that a resident territorial male is present. The intruder usually does not challenge the territory holder but withdraws when confronted with the display. In the Carolina anole, interestingly, the submissive intruder turns brown as he withdraws, in marked contrast to the bright green victorious resident. Maintaining territories, in turn, is important as a means of spacing the population and dividing resources. Also, since females are allowed to live on a male's territory unmolested, it provides a means of spreading access to females throughout the male population. The distribution is not necessarily equitable, however. In at least one species it was found that larger males had more females on their territories than smaller males. The size of the male is itself communicated by the aggressive display, since he usually postures sideways to an intruding male.

When a male iguanid encounters a female on his territory he at first uses display patterns similar to those he uses when he encounters a male. But his behavior soon changes when the female's response to him indicates her sex. If the female's physiological state makes her unresponsive to courtship, she immediately begins a ritualized rejection display, rising up from the ground on all four legs, arching her back, and raising her tail in the direction of the male. She may then take a number of short hops away from the male. This stately performance appears to discourage any attempt at courtship.

The male's courtship, in all species in which it has been observed, follows a similar pattern, He approaches the female with his head lowered and begins to nod rapidly. He may follow the female for a short distance, continuing to nod his head at intervals. If the female is willing to breed, she permits him to mount her and grasp the skin of her nape or shoulder with his mouth. The male then brings the base of his tail in contact with the same region on the female. Male lizards have two copulatory organs—or "hemi-penes"—enabling the male to curl his tail under the female's on either side of her body.

Glimpses into the day-to-day life of iguanid lizards are rare; the members of this family are so numerous and so varied that human curiosity has so far only scratched the surface. While the mystery of the family's distribution remains to challenge paleontologists, in the case of many species the barest details of life history are so poorly known that a patient amateur can contribute much. And lizard watching is a joy in itself, whether in the zoo or at a suburban wood-pile. The lizard's deliberate movements seem to accentuate the importance of everything it is doing, and patience is rewarded with the sudden emergence of a highly ritualized behavior pattern such as an aggressive display. The lizard's activities may seem simple and few to us, but there is an intensity in their performance that seems missing in our own more complex behavior. As D.H. Lawrence expressed it, "If men were as much men as lizards are lizards, they would be worth watching."